Chapter 12 Army Vision of Future SATCOM Support

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Army Vision 2010 serves as the link between Force XXI and the second future period, Army-2010 and Beyond (formerly known as Army After Next).

OVERVIEW

The Army future Satellite Communications (SATCOM) vision is intended to promote a common view while supporting and complementing Joint Vision 2010. This chapter provides a glimpse of how the Army SATCOM architecture could look in the future and what types of missions SATCOM might be called upon to support. The future timeframe this chapter will address is broken down into two distinct periods. Recall that Force XXI is the ongoing process that the Army is now undergoing to manage change as it advances into the 21st century. It is the Army of the 21st century out to the year 2010 that culminates in what is known as "Army Vision 2010."

Army Vision 2010, a critical component of Joint Vision 2010, identifies the patterns of operation, concepts, enablers, and technologies the Army needs in the 21st century to convert its vision into reality. Army Vision 2010 serves as the link between Force XXI and the second future period, Army-2010 and Beyond (formerly known as Army After Next). Army-2010 and Beyond is intended to conceptualize the geostrategic environment thirty years into the future. It envisions an Army of truly revolutionary capabilities. Control and use of space and satellite communications, as well as the supporting information-related technologies that will sustain this capability, are expected to play an increasingly important role in military operations, both by the United States and potential adversaries beyond 2010.

Because Department of Defense (DoD) satellite communications resources are inherently joint, the development of the Army's future SATCOM architecture must be a coordinated effort between the DoD, sister services, and major Army commands. SATCOM is just one part of the Defense Information Infrastructure. In order to support the warfighter with seamless connectivity, SATCOM must be closely complemented with terrestrial, air, and sea communications.

The development of a "roadmap" for a future Army SATCOM architecture takes into consideration current DoD space policies, architecture options, technology advancements, funding streams, joint concepts, and requirements. Added to this mix are Army concepts and requirements. Senior leaders' input, guidance, and assessment of options are all important in the formulation of the roadmap (figures 12-1A and 12-1B).

Note that the Army future SATCOM architecture is a vision – a "best guess" estimate of how SATCOM support to the warfighter could look in an uncertain and dynamic future environment. Unforeseen changes in technology, funding, requirements, objectives, and other variables understandably may alter this picture. Even less predictable are geopolitics which are quickly influenced by world events. Nevertheless, this future vision of the Army's use of SATCOM is based upon today's knowledge, technology, and capabilities as well as what can be foreseen of these with reasonably high confidence.

DEVELOPMENT OF THE ARMY VISION

Determining the best mix of owned and leased space capabilities, management and control systems, and terminals to provide optimum support to the warfighter within fiscal constraints is a tremendously complex problem for DoD and the Army. There are no predefined solutions to the problem. In the development of the Army vision of objective SATCOM architecture, several

Figure 12-1A Army SATCOM Mobile Multichannel Terminals Migration

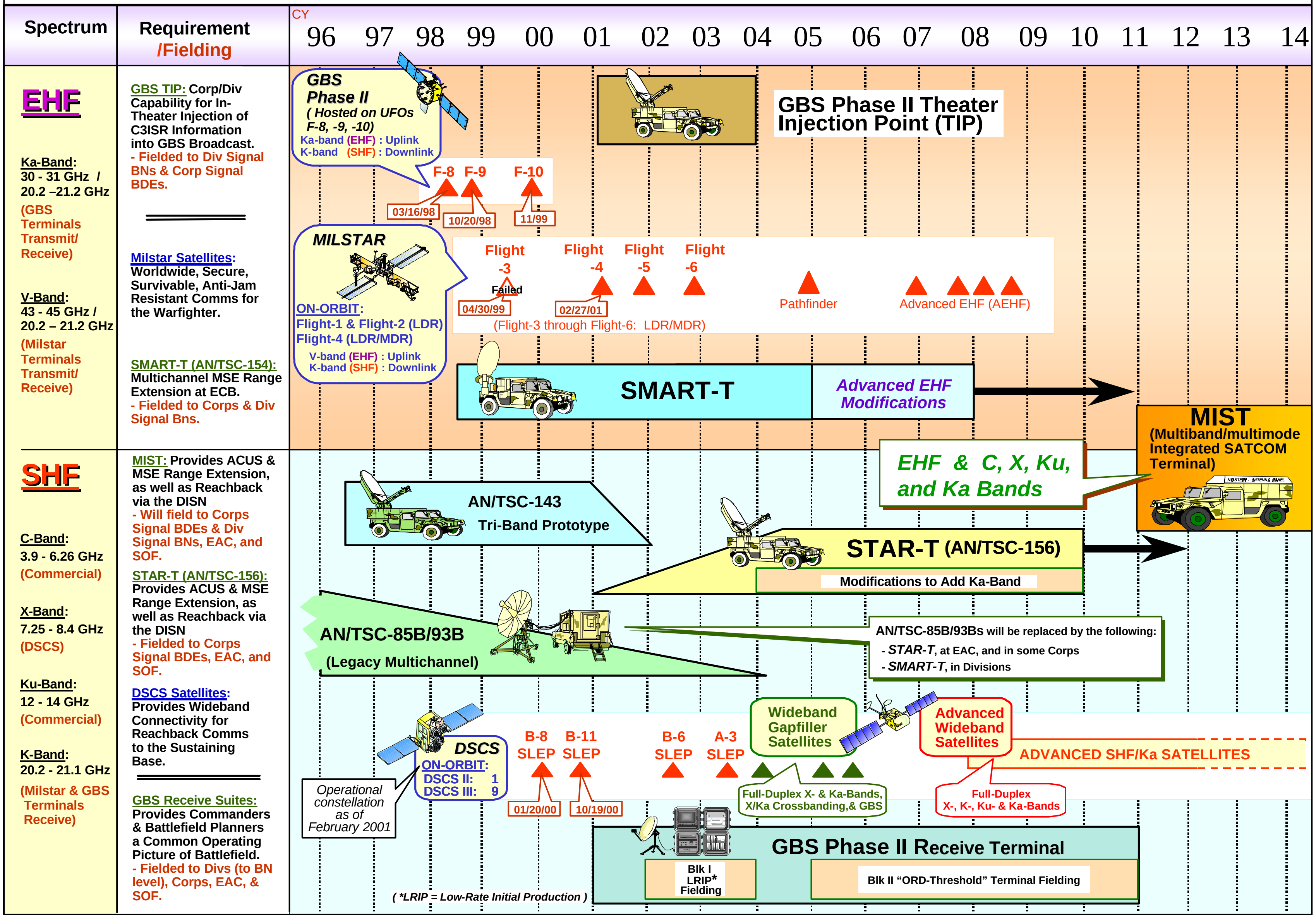
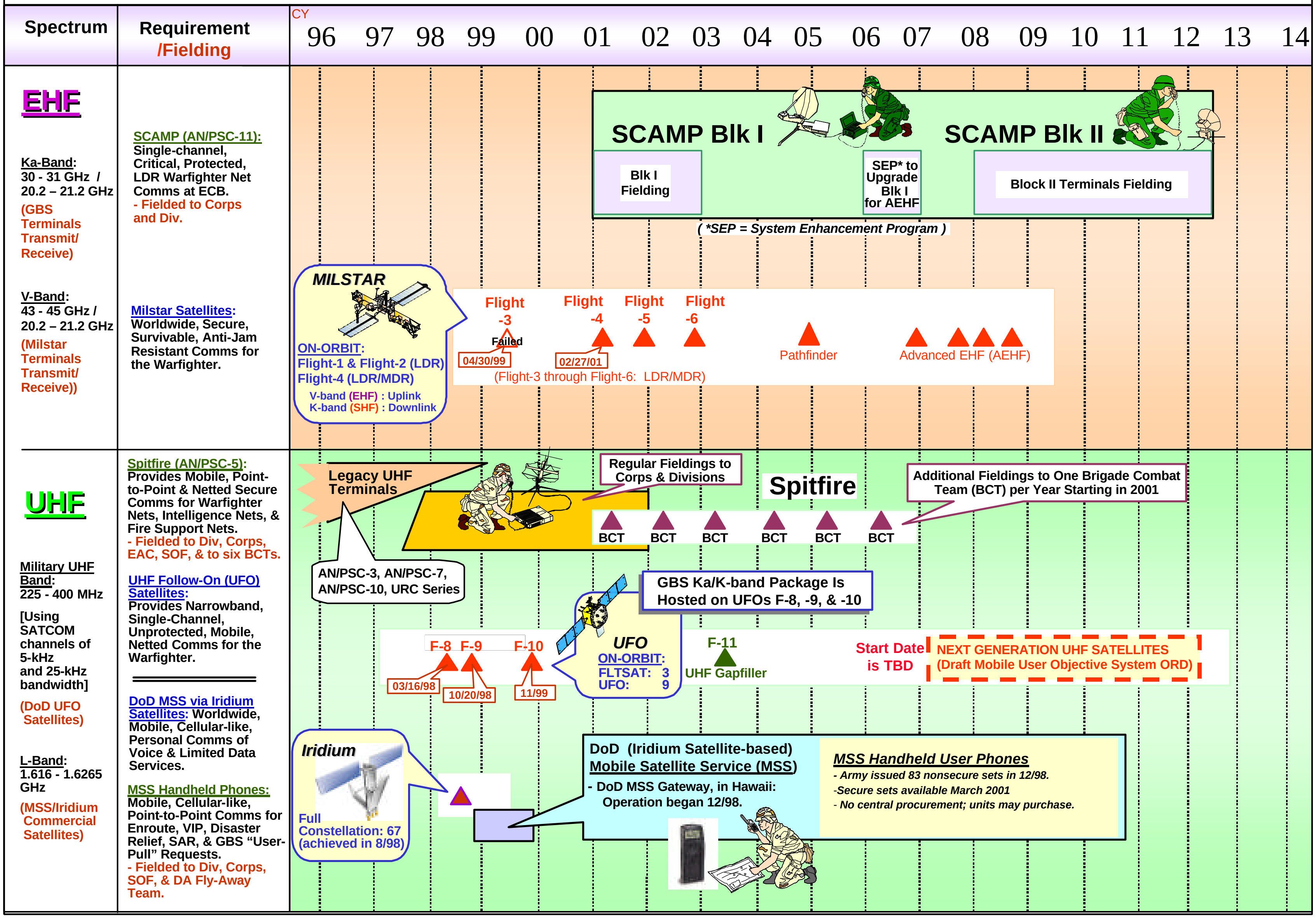


Figure 12-1B Army SATCOM Mobile Single-Channel Terminals Migration



As a "living" document, the DoD Space Master Plan will be periodically reviewed and revised as needed to define a clear path to obtaining capabilities derived from space systems to satisfy validated requirements.

Commands such as USSPACECOM and SMDC have the potential to identify space relationships not immediately obvious to a single service, civil agency, or commercial enterprise.

important DoD plans and concepts must be thoroughly researched and reviewed to ensure that formulation of the Army's blueprint for the future is a synergistic effort with the joint community.

The DoD Space Architect is responsible for developing space architectures across the range of space mission areas. These mission areas are space support, space control, force enhancement, and force application. Additionally, the Space Architect is responsible for integrating validated requirements into existing and planned space system architectures. He analyzes planned SATCOM systems to ensure they are in compliance with the direction of the master plan. As a joint technical agency, the Space Architect develops architectural recommendations to enhance the utility and affordability of current and future space systems.

A DoD Space Master Plan is a SATCOM architectural "roadmap" developed and maintained by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence with the support and assistance of the Space Architect. The DoD Space Master Plan depicts how current space system architectures should evolve to provide required capabilities. At a minimum, the DoD Space Master Plan includes a description of the existing space systems and architecture, planned or proposed space architecture, modifications to existing space systems, transitions from existing to planned architectures, space-related technology programs, technology infusion opportunities, and interoperability with U.S. Allies for coalition operations. As a "living" document, the DoD Space Master Plan will be periodically reviewed and revised as needed to define a clear path to obtaining capabilities derived from space systems to satisfy validated requirements. The Army objective SATCOM architecture must then also be reviewed and revised if necessary to stay current and compatible with the DoD vision and to ensure that the warfighter can be properly supported with satellite communications.

In the development of the Army objective SATCOM architecture, many joint documents and concepts are reviewed and used in formulating a general picture of how the architecture could look. Among these are the Advanced Military Satellite Communications (MILSATCOM) Capstone Requirements Document and the Long Range Plan for Space (both compiled by USSPACECOM), approved Army Operational Requirements Documents (ORDs) and approved Concepts of Operation. These joint documents are important in constructing an overarching plan for Army SATCOM through 2010. Commands such as U.S. Space Command (USSPACECOM) and Space and Missile Defense Command (SMDC) have the potential to identify space relationships not immediately obvious to a single service, civil agency, or commercial enterprise. Identifying common requirements or opportunities for efficiencies across service and civil programs can benefit everyone. Such space-focused commands are uniquely positioned to help consolidate missions and debate upgrades to capabilities in space and other mediums from an integrated systems perspective.

The Army's Training and Doctrine Command (TRADOC) has published *Concept for Space Support to Land Force Operations, TRADOC Pam 525-60,* which describes space capabilities the Army should exploit and integrate into its land force operations in support of national military strategy. This concept uses emerging concepts and doctrine as a foundation for informing, educating, and stimulating thinking into how the Army might best use space capabilities to enhance Army Operations. Although TRADOC Pam 525-60 is under revision at this time, the original concept can be accessed via the Internet at *www-tradoc.army.mil/dcscd/pam52560.htm.*

FUTURE WARFIGHTING THREATS AND CHALLENGES

Establishing a framework for envisioning future Army SATCOM operations requires anticipation of the global environment and potential challenges that the Army could face. The possibilities are daunting. Preparing for and meeting these possible challenges depends on having the relevant doctrine, superior training, innovative education and leader development, organizational design, materiel, and most importantly, high-quality people.

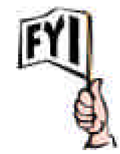
The USSPACECOM Long Range Plan for Space (1998) supports Joint Vision 2010 and provides a glimpse into expectations and goals for DoD future space capabilities as well as what the Army might expect to see on future battlefields. It is very enlightening. Battlefields will not necessarily be in the form envisioned today. Although the threat of large-scale worldwide conflict is not very likely, such conflict remains possible in a world made increasingly smaller by sophisticated transportation and communications. Future battlefields may encompass political, economic, and technological threats as well as expected military threats.

The number of developing countries that face serious instability and potential failure will increase and the environment will deteriorate. While some developing countries will experience economic growth, the poorest nations will face declining standards of living. Mass communications will convey these differences, leading to political instability in some places. These nations will require assistance from the world's developed nations and international aid organizations.

Conflicts, ranging from small regional disputes to full blown wars will be generated by groups devoutly devoted to their own nationalism, ethnic separatism, religious extremism, and/or disparities in resources and quality of life. Other non-government organizations, such as drug cartels, terrorist organizations, and crime syndicates might also be inclined to spark unrest in developing countries. Temporary alliances will emerge between countries unfriendly to U.S. interests. Even conflict that is not directed at the United States could threaten U.S. interests and the safety of American citizens.

The global economy will rely extensively on information processing. The exploding commercial development of space capabilities will make space products accessible to any adversary with the money to buy them. Although access to information should be comparatively equal for most nations, superiority will depend on the speed and accuracy at which it can be integrated and understood. It will also depend upon the ability to deny or degrade an adversary's systems while defending one's own. The blending of commercial and military satellite systems will hinder the ability to distinguish when an enemy is gaining the advantage. The SATCOM "playing field" will no longer be tilted towards U.S. forces.

We cannot rule out that the future battlefield could well be within the borders of the United States. Domestic challenges to national security include drug trafficking, computer



With the strengths and vulnerabilities of the U.S. military, there are virtually no adversaries capable of matching the U.S. in organization, training, and military equipment. The threat lies in potential adversaries developing low-cost methods to prevent the U.S. from its ability to project its military power. This could be accomplished many ways, from exploiting the aversion of the U.S. public for casualities to seeking ways to disrupt U.S. information superiority.

More may not be better! A critical challenge for decisionmakers is fusion of data into knowledge. Access to more data may actually inhibit, rather than support, the warfighter's decisionmaking unless data is fused into reliable knowledge. Any uncertainties regarding the accuracy or completeness of the data must also be conveyed so that the warfighter can assess the impact of this uncertainty on decisions.

hackers, immigration across U.S. borders, and disaffected groups in the U.S. acting in concert with hostile foreign powers, as well as terrorist attacks on federal information and control institutions.

In the recent past, the majority of military space planning has focused on a single threat with associated system applications. The future threat for the warfighter could come from any direction and the strategy must be creative and flexible to counter this unknown threat. Those who can most quickly and effectively process, analyze, prioritize, disseminate, and correctly act upon available information will gain a distinct advantage. Space superiority during conflicts will be critical to Army success on the battlefield.

Faster, more accurate and reliable information will be the key in dominating the anticipated high-technology battlefields of the future. However, better technology will not win wars—it will just give the warfighter an edge. In the future, potential adversaries will have access to the same technologies that will include displays showing disposition of forces, weather data, navigational tools, imagery, and regional situational awareness. Additionally, they will share and/or compete for commercial satellite communications services. Gaining superiority in space will be tough. U.S. adversaries clearly understand the force multiplication power that space provides. The Army must anticipate now what will be needed to keep the edge in space in the objective timeframe.

FUTURE SATCOM REQUIREMENTS FOR THE WARFIGHTER

The Army future SATCOM architecture will be driven by the requirements of the warfighter. Future Army forces will be highly technical and information dependent. The key communications challenges will be in maintaining command and control, obtaining and processing the raw data into actionable information, and then distributing that information to the warfighter much faster than today.

The three most critical satellite communications features required by the future warfighter are terminal mobility, high capacity, and protected/survivable links in a threat environment. In a nutshell, the basic requirement will be to get more secure data more often to more warfighters while they are moving. With that said, care must be taken to ensure that future commanders and warfighters are not overloaded with information. Systems can always be built that can outstrip human physical and mental capabilities. Rapid information processing should help and not hinder soldiers in accomplishing their mission.

The warfighter must be able to communicate while on the move with small, light, multipurpose terminals. Mobility is one of the most critical requirements on which future Army SATCOM architecture will be focused. A commander and his supporting operations element require immediate assured access to the combat forces and intelligence elements supporting their current operations. Secure voice, data, and graphics are required. The commander must have the capability to get a current, comprehensive picture of the battlefield quickly so that informed decisions can be made regarding the battlespace for which he is responsible. The SATCOM system that accommodates Command and Control On-the-Move must be integrated into the commander's fighting platform.

The capability to provide mobile netted communications services may be unique to a military system. There is no commercial equivalent to date. There are planned commercial systems that will be designed to provide global cellular service that may be an equivalent to mobile netted SATCOM. With a healthy Ultra High Frequency (UHF) space communications system and the introduction of several commercial satellite/cellular hand-held telephone services, there is an opportunity for the Army to experiment with differing approaches in providing mobile communications services to the warfighter.

FUTURE SATCOM TECHNOLOGY FOCUS

The Army's focus for technology development in modernizing its space assets is to exploit space for the Army warfighter. Army leadership is very active in influencing satellite designs and pushing for desired capabilities on satellite payloads that may still be on the drawing boards. Therefore, the Army's space-related research looks toward the following capabilities for the future warfighter:

- Establishing a reliable, secure, space-based communications network to operate through adverse weather, space environment anomalies, and threat conditions.
- Communicating via SATCOM On-the-Move.
- Interconnecting split-based operations at Medium Data Rate and High Data Rate.
- Navigating accurately across featureless terrain in all weather.
- Obtaining specific, high-interest targeting information during day/night operations and through weather and concealment.
- Measuring and predicting weather conditions accurately over areas of interest.
- Identifying friend, foe, and neutral forces.
- Providing theater missile attack warning and cueing to friendly forces and allies.
- Providing real-time, survey-quality pointing accuracy for directional systems including weapons systems.
- Providing immediate, seamless rerouting of communications over alternate means in the event of system failures, space environment anomalies, or destruction by enemy forces.

Progress has been made in achieving these objectives through advanced technology demonstrations, simulations, and experimentation. Army acquisition strategy includes using non-developmental items, commercial off-the-shelf equipment, and commercial, civil, and tactically oriented satellites to improve warfighting capabilities.

ARMY XXI SATCOM ARCHITECTURE

Space Segment

<u>DoD Constellation Replenishment</u>

The Army SATCOM architecture will see capabilities and communications resources increase over time as the objective architecture is approached. Using modeling tools, simulations, and special analysis techniques based upon anticipated future SATCOM requirements found in the Emerging

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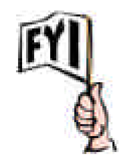

Commercial SATCOM technology is evolving at a pace that can be measured in months, not years. A key challenge for the Army (as well as all of the DoD) is to continue to develop an appropriately responsive acquisition system that can exploit, procure, and field commercial SATCOM hardware and software capabilities for the Army quickly and cost-effectively.

In transitioning to objective SATCOM systems, there must be no degradation or gap in the quality or quantity of required communications.

Using commercial SATCOM services and technologies could satisfy many Army communications requirements more economically, but prudent decisions must be made.

Requirements Data Base and the Integrated Communications Data Base, replenishment needlines for current DoD constellations have been estimated. The replenishment timeframes are an estimate of when the existing constellations can no longer be maintained at their desired constellation sizes with satellites that are still operating at stated levels of capability and utility to the warfighter.

USSPACECOM, Defense Information Systems Agency, and all service representatives do intensive, ongoing studies and analyses to determine the best way to reach objective architectural goals. The findings coming out of these studies are used to consider procurement of the next generation of MILSATCOM satellites. Other factors that must be considered are availability of DoD funds, an anticipated growth in SATCOM requirements of four to five times, acquisition strategies, launch strategies, and expected degradation of current space assets.

For all practical purposes, all current DoD-owned SATCOM systems will no longer maintain their desired constellation sizes during the first decade of the 21st century. Life expectancy dates have been calculated to determine when each constellation can be expected to reach the end of its useful life. The dates serve as one way to develop a schedule of procuring and acquiring the next generation of DoD SATCOM systems. Other factors that must be considered are funding and the expected growth in warfighter requirements.

In transitioning to objective SATCOM systems, there must be no degradation or gap in the quality or quantity of required communications. New systems should be brought on line as quickly as possible. Backward compatibility should ensure a smooth operational integration of new DoD SATCOM systems and facilitate continuing operations while transition occurs. Less than ten percent of the force structure should be rendered incapable of mission accomplishment because of SATCOM transition.

The “smart” use of commercial SATCOM systems makes sense for the Army. DoD acquisition timelines cannot keep pace with the rapid developments in SATCOM technology occurring in the commercial arena. In order to meet judiciously selected Army SATCOM requirements where possible, the Army can capitalize on the commercial sector’s existing and planned capabilities, services, and infrastructure. Satellite technology will continue to evolve towards more powerful satellites, and increased use of digital onboard processing.

Solar cell efficiency is an example of the dramatic improvements being made in the commercial sector that could be leveraged for the Army. The doubling of solar cell efficiencies means that satellite power can be doubled. Another important technology undergoing change is digital communications and affordable data compression. The commercial satellite market is closely watching and acting upon the explosion of inexpensive information technology. As more and more computing power falls into the hands of consumers, the public, private, and military networks will become strained by capacity and bandwidth limitations. In anticipation, satellite companies are developing plans for broadband satellite networks. Using commercial SATCOM services and technologies could satisfy many Army communications requirements more economically, but prudent decisions must be made. There is potential risk in committing to new, revolutionary commercial space systems that promise capabilities not yet demonstrated. There are still some unique Army requirements that must be funded and satisfied using DoD space resources.

Mobile User Objective System/ Advanced Narrowband Concept

The Mobile User Objective System (MUOS) is a joint program that will initially supplement and ultimately replace the current UHF Follow-On (UFO) system now in use. The UFO constellation, which was initially launched in 1993, will begin to reach the end of its design life around 2003. In order to maintain UHF availability at an acceptable level, a narrowband acquisition strategy was jointly developed. The MUOS is a component of this strategy.

MUOS is targeted for operational service in 2007. The purpose of the MUOS is to seamlessly blend into the DoD space-based network of satellites and associated facilities providing narrowband communications services for a worldwide population of mobile and fixed users. It will extend Defense Information Infrastructure connectivity to mobile users and fixed subscribers and will be a complement to other communications architecture components.

The requirements for the MUOS system are derived from the MILSATCOM Mission Needs Statement, the Advanced MILSATCOM Capstone Requirement Document, and the MUOS ORD. Although the U.S. Navy has been charged with the acquisition responsibility for MUOS, they are working closely with the other Services to ensure commonality and interoperability are maintained. The principle objectives of the MUOS are to provide warfighters with assured access to communications, netted and point-to-point communications, worldwide (including polar) communications coverage, joint interoperability, and communications on the move.

While the MUOS will be a system comprising spacecraft, spacecraft control elements, and network control elements, it is envisioned to be a part of a larger "system of systems" known as the **Advanced Narrowband Concept (ANC).** As an overarching communications architecture, the ANC will consist of MUOS along with other narrowband communication elements such as ground terminals, teleports, and commercial SATCOM.

There are other desired capabilities that are important and that may be deemed appropriate for any future MUOS. Although many of the capabilities are not technologically possible today, the incredible advances being made in communications services will surely eliminate current shortfalls in the future.

DSCS SLEP to Advanced Wideband System

The Defense Satellite Communications System (DSCS) has been providing the bulk of DoD's long-haul, high-capacity (wideband) satellite communications requirements for many years. The increased tactical needs of the warfighter, however, require an upgrade to the current DSCS system. To meet these needs, the remaining four DSCS payloads will be enhanced under a Service Life Extension Program (SLEP). The DSCS SLEP satellites will provide five times as much data throughput in direct support of tactical users. There is still a period of time after the last DSCS SLEP is launched until the first launch of an Advanced Wideband Satellite System. This will be filled by the Wideband Gapfiller satellites, which were discussed in Chapter 5.

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Protected communications, like that provided by Milstar and its follow-on AEHF, is <u>not</u> a luxury but a necessity for the warfighter. These systems are unique in that they do not rely on commercial infrastructure (over which DoD has no control) to operate and thus are much less vulnerable to a myriad of external threats.

The Advanced Wideband Satellite (AWS) will be acquired to continue wideband fixed-to-fixed communications and tactical unprotected service now performed by DSCS and Global Broadcast Service (GBS) packages on UFO satellites 8,9, and 10. The AWS program is conceived to be three DoD-owned, high-capacity, commercial-like satellites to be launched beginning in 2008. These satellites will include high-capacity Super High Frequency (SHF), a GBS package comparable to that on UFOs 8, 9, and 10, and a two-way, Ka-band capability that will assist the DoD in moving to a future MILSATCOM architecture dominated by Ka-band communications. This capability, when combined with DSCS SLEP and GBS, will provide a dramatic increase in tactical capability for the warfighter. The AWS will more directly replace both the SHF/Ka-band Wideband Gapfiller satellites and the UFO GBS segments.

<u>Advanced EHF SATCOM</u>

Advanced Extremely High Frequency (EHF) (AEHF) is the successor to the Milstar satellite communications system. The first of four AEHF satellites is scheduled for launch in 2006. The AEHF satellites will not only replace the satellite portion of the Milstar system but also will also significantly improve the capabilities of almost all the Milstar ground terminals and control assets. The AEHF system will be the DoD's primary system for highly protected satellite communications through 2020.

The requirement for a protected, survivable communications service is unique to the military. There is no commercially available equivalent. The architectural goal of the Extremely High Frequency (EHF) satellite system is to provide adequate protected and survivable communications services to allow the warfighter to continue his mission during all phases of a military operation. The transition strategy from today's Milstar system to a future EHF system is to continue to field a processed and crosslinked EHF system, improving capability incrementally. AEHF will provide communications range extension for the Warfighter Information Network (WIN) for Army divisions and corps. AEHF will be equally critical to many tactical users as DoD moves toward more commercial systems that have little in the way of unique protection features. AEHF will provide data rates five to ten times greater than the current Milstar constellation supports with equivalent levels of protection. In addition the system will be compatible with existing Milstar ground terminals, and provide a seamless connection with the Milstar satellite crosslinks.

As of May 2000, the AEHF program is in the 18-month System Definition phase. This process involves two contractors – Lockheed-Martin Missiles and Space and Hughes Space and Communications Company— who will compete to derive an AEHF end-to-end system for highly protected military satellite communications consistent with the DoD system specification. After completion of this phase in 2001, one of the two teams may be awarded the production contract.

SATCOM Ground Terminals

Future Army SATCOM terminals of all types must be smaller, lighter, and more capable to meet deployability requirements and to allow forces to communicate while in the process of deploying. They must be fully integrated functionally and physically with the warfighting platforms and/or systems that they support. The terminals must not impact the mobility or basic warfighting capabilities of those supported systems. Terminal and antenna designs of future systems and how they are integrated into the mobile warfighter platforms will be critical to ensuring that the user's mobility is not adversely affected in any way. Since many warfighting platforms are multi-mission in nature, a mix of SATCOM terminals likely will be carried on the same platform. Co-site frequency interference and physical interference are problems that will need to be addressed and resolved.

Army ground terminals of the future that are not embedded as a subsystem in a warfighting platforms and which require set-up and tear-down, should be capable of being set up and placed into operation in a matter of minutes. This includes satellite link acquisition and link activation times. Realignment, reorientation, and tear-down time should be about the same or less than set-up time. Transportable terminals that are deployed and used by concealed ground forces should be designed in a way that minimizes the physical size of the terminal and prevents detection of the terminal's presence and location.

Today most terminals used by the Army are a single- purpose/single-user classification. In the future, the numbers, types, and sizes of communication terminals that the warfighter needs should be reduced. The ground terminals, where possible, should be multi-purpose, multi-spectral, and multi-mode. They should be capable of use on a variety of military or civilian frequency bands, while supporting a variety of waveforms and modulation schemes. Also, protection features are a desired capability in some applications. The reason for a multi-capable terminal is derived from the need to reduce the amount of equipment that must be deployed and carried by the warfighter who will need to communicate flexibly with or through a diverse number of "digitized" battlefield weapon systems. A small multi-capable terminal would significantly improve the warfighter's tactical mobility and survivability.

Existing SATCOM systems may not have reached the end of their useful lives and can still be of value to the warfighter. Residual space segment will remain and legacy ground terminals, many of which will have been fielded in the 1998-2005 timeframe, will still be a part of the communications architecture. Transition and future DoD-owned constellations more likely will be a mix of legacy and new systems. A degree of backward compatibility in new systems may be essential in providing interoperability with older systems.

Future Army ground terminals should be backwardly compatible with existing systems or offer an operationally and cost effective transition where departure from compatibility occurs. Care must be taken when assessing trade-offs and to what degree backward compatibility should be implemented. Advanced capabilities should not be deferred in the future architecture just to achieve backwards compatibility.

<u>The Multiband/Multimode Integrated Satellite Terminal</u>

The requirement for a multiband/multimode integrated satellite terminal (MIST) is supported by the Advanced MILSATCOM Capstone Requirements Document (CRD), the WIN Master Plan, and the Army Space Master Plan. "Multiband" means to be able to communicate over three or more bands with the band designated for transmission determined by the system using best available transmission/reception paths with sufficient capacity available to satisfy information requirements. "Multimode" means that the terminal is capable of selecting a terrestrial or space-based

Terminal and antenna designs of future systems and how they are integrated into the mobile warfighter platforms will be critical to ensuring that the user's mobility is not adversely affected in any way.

The warfighter must have the freedom and flexibility to move quickly on the battlefield using a communications terminal that is tactically responsive, mobile, interoperable, and capable of communications-on-the-move.

Assured access to SATCOM is the most important requirement for the warfighter.

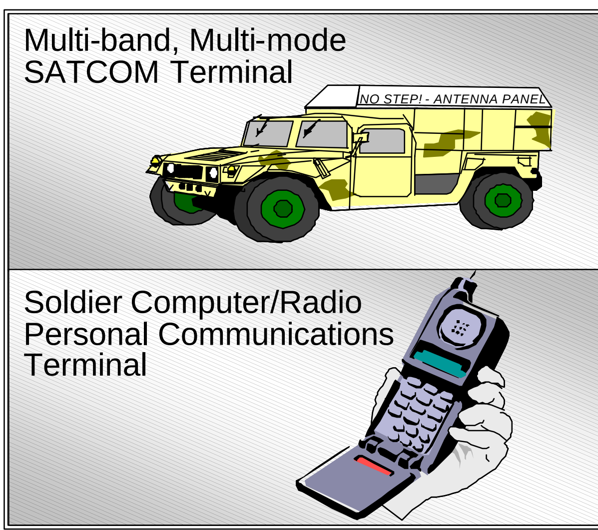
path for transmission based upon best available path. The warfighter must have the freedom and flexibility to move quickly on the battlefield using a communications terminal that is tactically responsive, mobile, interoperable, and capable of communications-on-the-move (figure 12-2).

The warfighter cannot depend solely on one frequency band to satisfy all his needs. Spectral diversity and use of the total existing electromagnetic spectrum to meet warfighter requirements is essential for future military missions. The MIST should be able to communicate using the C-, X-, Ka-, and Ku-bands, as well as the EHF band. Frequency band changes should be accomplished either manually or automatically. The MIST must provide variable, mission essential, military and commercial connectivity to distant end subscribers including data, imagery, video, and voice communications. It should have the capacity to be configured with an embedded switch. This capability will provide the warfighter additional flexibility. MISTs would then be configurable into a "switch version" and "non-switch version" depending upon the mission need. The switch version would replace the transmission and switch assemblages at Command Posts. The non-switch version would be utilized at signal nodes. The terminal must be interoperable with all current and planned fieldings of SHF and EHF terminals. The MIST must have the ability to function as a signal node with tandem capability, multiple trunk groups, and multiple local subscribers.

SATCOM Access and Network Control

<u>Assured access to SATCOM</u> is the most important requirement for the warfighter. This means that the necessary amount of commercial and/ or DoD-owned SATCOM services are available and accessible to the warfighter when and where needed. The warfighter relies heavily upon SATCOM for mobile, deployed, and enroute beyond line-of-sight communications. The SATCOM resources, which include satellites as well as terminals, should have the ability to be configured or reconfigured by the operational commander based upon a changing mission and be accessible to him for the duration of that mission.

<u>SATCOM control</u> is concerned with the ability and processes needed to



MIST Characteristics

- Tactical network terminal capacity increase up to interactive video, battlefield simulation data rates
- Embedded ATM Switch/variable digital trunk rate
- Signals comprise communications bits/not synchronization bits
- Wireless connection to all battlefield functional areas
- Embedded international information protocols for worldwide interoperability
- Lightweight, mobile terminal
- Multilevel security
- LPI/LPD Waveform
- Multi-band radios, with planar array antennas electronically optimized per frequency band
- Voice recognition quality to speech transmissions

Figure 12-2. Ground Terminal Potential Objective Characteristics effectively plan, monitor, operate, manage, and re-engineer available SATCOM resources. Since SATCOM resources are limited, commanders must have control over their allocated resources and establish procedures to ensure that access is planned, granted, and managed in accordance with operational priorities. Future Army SATCOM access and control would include the following capabilities:

- Timely and responsive processing of apportioning and reapportioning SATCOM capacity
- Access of SATCOM capacity is controlled by commanders at the lowest appropriate levels
- Allocated resources that can be rapidly and dynamically reconfigured when necessary
- Accommodation of new or unscheduled user requests for SATCOM
- Performance monitoring of allocated resources
- SATCOM integration that is present in end-to-end information transfer planning

Future Requirements for Network Control

Joint Staff planning, apportionment, and allocation of DoD SATCOM resources is a critical requirement. It is important to understand that it is at this level where major segments of the DoD SATCOM system (including leased/pay-per-use commercial, polar, and broadcast services) can be planned, managed, and coordinated so that the warfighter and other validated users at the lowest level are provided optimum support. The Joint Staff is responsible for apportioning joint SATCOM resources among all unified combatant commands and DoD agencies. For future multiple contingencies and the ever-present possibility of deployment of U.S. forces, the planning and implementation cycle for DoD SATCOM resources must be much faster and more responsive.

Once the unified combatant commanders or other users have received their allocations of SATCOM resources from the Joint Staff, they have the requirement to be able to sub-allocate some or all of their resources to subordinate commands or components. Subordinate echelons in turn may choose to further sub-allocate based upon the current operational mission. SATCOM resources MUST be applied at the lowest level appropriate so they can be used and focused specifically to where they are needed in near real-time. Together with the receipt and use of SATCOM resources, the commander must have the ability to plan, manage, monitor, and control the allocated resources. Until there is a change in mission priorities or a higher-level commander changes the allocation, the subordinate echelon can manipulate the assigned resources to best accomplish the mission. For high-priority requests at this level, access to SATCOM is required to be obtained in as little as 30 minutes after the request is made.

There is a requirement for effective access control that would authorize, deny, or preempt access as appropriate. SATCOM resources are limited. Only those users who have valid requirements and proper authorization can obtain service.

There are some DoD SATCOM service requirements that must be under the control of the United States. U.S. control means that the system is under the direct control of a private or government agency that is subordinate or directly responsive to the direction of U.S. authority. This is important because foreign governments, companies, or other international agencies may not respond to or support U.S. requirements due to political, labor, or social issues. The warfighter cannot be required to rely on foreign controlled systems for critical communications connectivity.

The Joint Staff is responsible for apportioning joint SATCOM resources among all unified combatant commands and DoD agencies.

SATCOM must be clearly understood as just one portion of the overall global communications network.

Future weapons systems will have integrated digital information sub-systems (versus having just digital communications) that are tightly integrated with the overall C4I system of systems. This capability will allow information available on individual platforms to be simultaneouly shared (via SATCOM) and acted upon across the battlefield.

Mission accomplishment could be severely compromised.

Dynamic network management is an essential requirement for the unified combatant commander who has been allocated SATCOM resources. Communications services must be established and reconfigured on those satellite systems to include links and interfaces into terrestrial commercial and military systems. The network management and control system must accept service requests and then rapidly plan, deny or provide access, set up, and activate the net. This system must be able to quickly adjust and re-apportion changing allocations of DoD commercial and military satellite services and resources. Commanders must have this capability to manipulate or shift their resources as missions and priorities change. Information transfer must be able to migrate between protected and unprotected services as needs, mission, and threat dictate.

SATCOM must be clearly understood as just one portion of the overall global communications network. The network management and control system should support planning, requesting, and implementing the end-to-end information transfer even if only a small portion of the communications is being relayed via SATCOM. Since not all users will have direct access to satellite communications, the network management and control system should facilitate access to other SATCOM or terrestrial communications media if necessary.

The network management and control system should have the automated capability to monitor the performance and operation of allocated SATCOM resources. This is to ensure system-wide efficiency and to make the best use of limited resources. Idle or unused capacity can be identified and reapportioned if necessary.

An integrated network planning, management, and control system is critical for the future communications architecture. The requirement is for an automated, highly responsive, easy-to-use, integrated planning and control system of databases and tools that can combine network planning and management, decision support and analysis tools, satellite access procedures, terminal and payload/platform control for all apportioned SATCOM resources both military and commercial. This integrated system must provide the commander and his staff with a clear and complete understanding of their SATCOM resources, the impact of those capabilities on missions and operations plans, what courses of action are possible, and how the resources will perform.

The network management and control system should be an integrating component of the Army SATCOM architecture rather than a component unique for each for communications system. Finally, it should be user-focused, designed to meet the needs of the warfighter quickly, accurately, and dynamically.

ARMY-2010 AND BEYOND

Projected Space Capabilities and Responsibilities

For Army forces in 2010 and beyond, space capabilities will be critical enablers to achieve information dominance and for ensuring full spectrum dominance across all levels of conflicts. Army leadership must be proactive in determining how best to exploit, leverage, and integrate military, civil, and commercial space technologies and capabilities into this future Army force.

As the Army proponent for space, the Army Space and Missile Defense Command (SMDC) is working to integrate space resource needs documented in the *Joint Vision 2010*, *Army Vision 2010*, *U.S. Space Command Vision for 2020*, and the *Advanced MILSATCOM CRD,* as well as insights emerging from the former *Army After Next* process. The SMDC vision is to provide the warfighter with space products that will allow land force dominance in the 21st century. In conjunction with major Army commands, they are developing technologies in areas such as communications, position/navigation, intelligence, surveillance, target acquisition, mapping, weather, and missile warning that support this vision. The bottom line is to support the Army's goal of developing space products that get the right information to the warfighter at the right time. For the Army in 2010 and beyond, the following space capabilities are considered key to successful mission accomplishment:

Robust Space Integration Into Full–Spectrum Land Force Operations

As demands on land forces increase, space must be integrated into the full spectrum of operations, from peacetime, domestic operations to large–scale force projection operations when overseas interests are at risk. To support these operations, data transported by space systems must be developed into relevant and usable information that must be tailorable to the needs of the warfighter. Because space is a joint resource, the Army must ensure that joint space doctrine, tactics, techniques, and procedures reflect land force needs. The Army must be proactive and push hard to ensure that space systems are designed to give land force requirements the highest priority.

Progressive Space and Missile Defense Technology for the Warfighter

It is critical for the Army to emphasize and participate in progressive space technology development. The Army will also participate in developing technologies for our nation's joint space and missile defense architectures. Priorities will be to ensure the protection of friendly space capabilities, the control of space and application of force from space and into space. The Army's focus for technology development in modernizing its space assets is to exploit space for the tactical commander. Therefore, space technology development is focused on providing the warfighter such capabilities as the following:

- Sensors that are multifunctional and leverage commercial technology
- Processors that serve to decrease the decision cycle, provide processing in–theater with rapid access to stored data, and provide automatic target recognition and advanced decision aids
- Assured access to medium and high data rate satellite communications
- Multiband terminals
- Space control efforts that deny enemy information capabilities and protect space assets.

Anticipatory Space Partnerships

It is no secret that the race is on in acquiring more access to space and satellite communications technology. The global military market is offering navigation systems, photo/imagery reconnaissance, and even electronic intelligence collection systems. Future adversaries will have domestically developed space systems, systems acquired from other countries

The Force XXI and Army-2010 and Beyond are actively identifying new concepts that could affect the way the Army will train and fight in the future. The Army's Experimental Force, the 4th Infantry Divison at Fort Hood, Texas, is the vehicle used for testing these concepts and innovations. The 4th ID uses SATCOM for examining the impact of new technologies that could facilitate command and control and the decisionmaking process for future warfighters.

hostile to U.S. interests, or they will get them on the world market. Information available today indicates that by 2025, probable adversaries will most likely have the same access to space, or nearly the same access, as U.S. forces. In the future, it is entirely possible that global partnerships will augment military space capabilities through the leveraging of civil, commercial, and international space systems. The Army must foresee the challenges inherent in a global operating medium. Of particular interest will be international alliances, mixed commercial and military space use, military capabilities onboard commercial satellites, ground station requirements, policies and treaties, partnerships with national agencies, and affordable, responsive launch capabilities. Satellite constellations in the 2010 and beyond timeframe might be fully shared among U.S. allies. This has a number of advantages with interoperability between allies and the U.S services being the prime advantage. Other advantages are the augmentation of U.S. satellite access using "excess" allied capacity, reduction in constellation costs because of the international investment, potential access to allies' International Telecommunications Union slots, and potential increase in market share for U.S. industry.

Future SATCOM Architecture Objectives

Future conflicts with which the Army will become involved will be unpredictable in location, time, duration, and intensity. SATCOM may be the only assured, immediately accessible communications means for the warfighter to relay critical information. As previously discussed, higher capacity and more flexible services must be designed and integrated into future space platforms and ground terminals. With warfighter requirements in mind, the future Army SATCOM architecture for the Army-2010 and Beyond should address these objectives:

• The warfighter should have assured, secure, responsive, robust communications services at the right place and at the right time. This would encompass everything from protected voice to services that would provide information superiority. A substantial increase in communications capacity and better service to "disadvantaged users" is required. Disadvantaged users include warfighters using manpack terminals, aircraft pilots and crews, forward deployed forces, and others operating in highly mobile platforms.

• SATCOM services should be fully integrated with the Defense Information Systems Network (DISN). The sources of communications services within the integrated networks should be transparent to the warfighter. SATCOM, with enriched interfaces and connectivity to the rest of the communications infrastructure, ideally must come to be viewed as but one transmission media option for the routing of information within the overall information services structure. This objective would require redundant seamless networking of cross-Service and interagency links and integration with other information services.

• Communications footprints should be reduced by improving the size, versatility, robustness, and maintainability of terminals, radios, and antennas as well as by reducing the associated operation and maintenance manpower requirements.

• SATCOM should be user-friendly and interoperable to permit a free flow of information across different echelons, theaters, and Services. The warfighter should be able to concentrate on his mission, with worry-free communications.

The evolution to the future Army SATCOM architecture will require undergoing a lengthy, intricate transition process that will unfold over time as capacity requirements, technical and operational opportunities, and funding permit. A critical primary transition goal is maintaining continuity of service by supporting timely satellite replenishment, wisely planned operations management, and judicious selection of transition tradeoffs. Other transition goals that are no less important include continuing to use demonstrations and modeling to facilitate new warfighting visions, accelerating the pace of ongoing changes in terminal developments toward flexibility and system efficiency, and fully integrating SATCOM into the overall communications architecture.

WHAT'S IN THE "CRYSTAL BALL"?

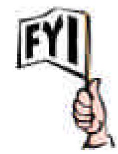
Unmanned Aerial Vehicles

As a complementary force, the use of Unmanned Aerial Vehicles (UAV) will be of real value to the future warfighter. Putting UAVs in "subspace" (over an altitude of 20,000 meters) above commercial air traffic where they could hover, float, or fly above a battlefield would provide visibility and additional communications capacity without jeopardizing lives. Future UAVs might be able to loiter for days fueled by solar power or fuel cells. In the 2020 timeframe, UAV technology might be so advanced and highly automated that small submunitions could be carried onboard for protection of the UAV. With long linger times and the ability to "see" the battlefield, UAVs could be programmed to spot, identify, and fire upon enemy targets. UAVs could also be a backup to a navigational capability currently filled by Global Positioning System (GPS) today.

Frequency Expansion/Reuse/ Antenna Technology

Progressing into "uncharted" territory by moving satellite communications technology into higher frequency bands would increase capacity, availability and provide fast, high-quality transmissions. The potential exists to build satellites that could reuse frequencies as much as 100 times, with advanced onboard operations even more robust than Milstar has now. One such technology envisioned is a bit-by-bit signal regeneration by fourth generation supercomputers coupled with new optimization techniques to overcome rain fade problems in the EHF frequencies. Certainly by 2020, these technologies will be a reality.

Miniature phased array antennas can be mounted on satellites to steer very focused beams towards intended recipients under the control of tiny supercomputers the size of a shoebox. With this technology, frequency reuse becomes possible. This technology might be reversed from ground-based antennas towards the satellite. Conformal antennas then could be shaped and sized towards almost any platform – tanks, helmets, handheld terminals, etc. The soldier in Army-2010 and Beyond would be able to call up links of data from many sources that would inform him of what is happening in his area of operations. The "smart helmet" worn by a future soldier would project a heads-up display of targeting information and terrain images received from satellites and send back into the network live video from a helmet-mounted camera. Another technology under development that could have future applications for Army SATCOM is best described as an "inflatable antenna."



Interoperability is an important factor in operational efficiency. Where interoperability is lacking, there is a likelihood that multiple systems are performing the same functions and information is being entered and processed multiple times. It also means that soldiers have to resort to "jerry-rigging" to obtain the required information. This is not only a waste of time, but it introduces errors into the overall system.

The incredible progress of the information revolution and technology development expected into the next century requires the Army to envision new ways of structuring SATCOM systems.

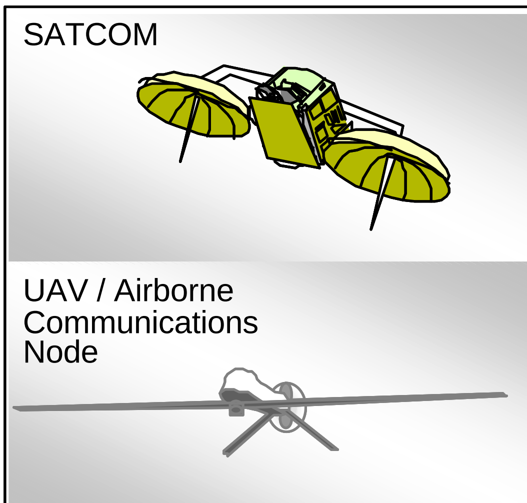
This type of antenna would improve mobility for the foot soldier and assist in decreasing the amount of space needed for storage and transport.

Multi-Band Satellites

The Army will always have a requirement for assured, protected, robust communications accessible to every warfighter on the battlefield. The incredible progress of the information revolution and technology development expected into the next century requires the Army to envision new ways of structuring SATCOM systems. Users will no longer have single channel, multichannel, or special-mission SATCOM systems. Instead, communications services will be provided entirely on an automated, demand-assigned, bandwidth-as-needed basis.

A multiband, multimode, spectrum-efficient satellite constellation is a concept well within the realm of possibility in the 2010 and beyond timeframe (figure 12-3). This constellation would provide seamless support to the warfighter and be accessible to him at any location worldwide. The warfighter would have one handheld (or smaller) terminal that could communicate via any satellite. No longer would terminals be designed, built, and differentiated by supporting frequency bands. With the inclusion of this type constellation into the Army SATCOM architecture, coordination between services or joint task force elements will be continuous and instantaneous. Intelligence will be focused and available in seconds. Multiband SATCOM supporting the Army's range extension requirements should have the following capabilities:

- Simultaneous multiband (e.g., UHF, SHF, and EHF) transmit/receive or similar functions performed by multiple, simple satellites
- High information throughput at all bands: 10+ gigabits for bands selected for long-haul range extension trunking
- Embedded Asynchronous Transfer Mode switch for on-the-fly call routing
- Low overhead processing (e.g., minimized overhead bits in data streams)
- Planar, phased array, high-gain antennas, electrically optimized for each frequency band
- Virtual "spot beam" for full-time support of disadvantaged (low power/



Communications Satellite Characteristics

- Simultaneous multi-band (UHF, SHF, EHF) transmit/receive or similar functions performed by multiple, simpler, satellites
- High information throughput at all bands; 10 Gbps throughput in band selected for long-haul range extension trunking
- Embedded ATM switch for on-the-fly call routing
- Low overhead processing (communications bits/not synchronization bits)
- Planar, phased array, high gain antenna, electrically optimized for each band
- Virtual 'spot beam' for full-time support to disadvantaged terminals
- Switched crosslinks to any communications satellite in view
- Interoperable with 'personal communications satellites'
- Orbits optimized for throughput and minimum delay
- Military capabilities 'package' with anti-jam processing/nulling , LPI/LPD, and scintillation mitigation waveform

Figure 12-3. Satellite Potential Objective Characteristics

small antenna) tactical terminals
• Switched crosslinks to any communications satellite and airborne communications node in view
• Interoperability with "personal communications systems" satellites
• Orbits optimized for information throughput with minimum delays
• Military capabilities package with anti-jam processing/nulling, Low Probability of Interception (LPI)/Low Probability of Detection (LPD), and natural scintillation mitigation waveforms.

Satellites in this futuristic constellation would sense transmission path impairments and automatically crossband to appropriate downlink frequencies for assured availability and ground coverage. Advanced LPI/LPD and anti-jam waveform characteristics will be implemented in a military capabilities package with capabilities of detecting, locating, and nulling jammers. Crosslinks among satellites and airborne communications nodes will assure coverage to tactical users, even in low look-angle fringe areas of the illuminated footprint.

The Army vision for future satellite systems in the 2010 and beyond timeframe assumes modest, but significant improvements in military space-based systems. This constellation, as described, is the visionary culmination of a military satellite system supremely optimized with the most superior technology and designed to support the warfighter's critical requirements for flexible, seamless, secure, and instantaneous global communications.

Satellite Transmission Speed

Satellites will need to be up to 1,000 times faster than those of today to handle the huge information transmission requirements that can be expected in the Army-2010 and Beyond. Interconnections with fiber-optic cable must be clean and transparent to the user. The speed of transmissions will be essential in targeting anti-satellite weapons that could adversely affect the U.S. ability to operate effectively. Navigational satellites (such as GPS) would be crucial to U.S. forces. If the ability to use these satellites were lost, it would severely impact U.S. precision, logistics, fires, maneuver and, in 2010 and beyond, the ability to distinguish friend from foe. Satellites will need to have the ability to deflect and/or destroy missiles that are launched in order to destroy the U.S. ability to maintain information dominance.

Miniaturization of Satellites

Satellites in the 2010 and beyond timeframe will be so small that they could be launched into space from the barrel of a large gun or small cannon. This would make launch on demand easier and more cost efficient. We are seeing the beginnings of this now, with multiple launches of smaller satellites into low earth orbit (LEO). Technology in the future might see shrinkage to the point where satellites of less than five pounds could be launched by light guns with hypersonic speed to attain orbit. Metals would have developed to the point where these launch vehicles would possess the structural strength to overcome the extreme aerodynamic heat and drag associated with hypervelocity launches.

Satellite Reconfigurations

Aerospace vehicles in the 2010 and beyond timeframe will be computer-designed at the atomic/molecular level, which will enable it to be structurally reconfigured to meet specific mission requirements. Programmable, multifunctional materials will be able to adjust their shape as well as their mechanical,

The Army vision for future satellite systems in the 2010 and beyond timeframe assumes modest, but significant improvements in military space-based systems.

__Beyond 2010, the U.S. will be so reliant on space systems that space superiority will be of vital importance.__

__In any future war conducted in 2010 and beyond, major U.S. space advantages (which must be clearly overwhelming) will be the quality of satellite and airborne intelligence, the efficiency of the communications network, and the ability of the navigational and sensor systems to guide missiles to their targets.__

aerodynamic, electromagnetic, optical, and acoustical properties on demand.

FUTURE SATELLITE SYSTEM VULNERABILITIES

Control of space will rest with the ability of the U.S. to command and control the myriad systems associated with the space and satellite mission. Today, U.S. counterspace capabilities are limited. They are primarily defensive and passive in nature. Military satellites in orbit now are, to some extent, hardened against electromagnetic pulse and radiation. Low earth orbiting satellites must be hardened to some degree because of their proximity to the Van Allen radiation belt. Satellite subsystems are now built with double redundancy in case of failure. Most satellites are launched with enough fuel to conduct minor maneuvering in an attempt to avoid attack. These are all passive, defensive measures.

Beyond 2010, the U.S. will be so reliant on space systems that space superiority will be of vital importance. Today, there are no countries with the technology capable of destroying space assets in orbit. Launch vehicles or nuclear weapons, however, could be purchased for the right price. In the 2010 timeframe, more countries will have the internal capabilities to wreak havoc in space, specifically targeting U.S. assets. The future, specifically by the year 2025, will see many nations capitalizing on using space as their vantage point for both military and commercial uses. The threat to U.S. satellites, military and commercial, will be very real. There is a compelling need to develop counterspace measures to protect critical Command, Control, Communications, Computers and Intelligence links and provide the constant situational awareness that warfighters must rely upon to be successful and stay alive.

Segment Vulnerabilities in Future War

Each segment of a satellite system (i.e., space, ground, and control) has its own vulnerabilities in a combat environment. Satellites, by nature of their mission, may be the most lucrative targets to attack, but political consequences may make such an attack unjustifiable. The same could be said for ground terminals.

In any future war conducted in 2010 and beyond, major U.S. space advantages (which must be clearly overwhelming) will be the quality of satellite and airborne intelligence, the efficiency of the communications network, and the ability of the navigational and sensor systems to guide missiles to their targets. Therefore, if a nation such as Iraq wanted to defend itself against attacks such as Desert Storm, the logical approach for it to take is to attempt to disable U.S. reconnaissance satellites. This action would eliminate the other major advantages, and battles would then be fought on much more equal footing. In the event of such a scenario, the most likely satellite targets would be these:

- Optical and reconnaissance satellites in polar and LEO orbits
- GPS satellites in semi-synchronous circular orbits
- Electronic Intelligence/Signals Intelligence satellites in both Medium Earth Orbit and Geosynchronous Earth Orbit

Satellites designed and launched in the future must be capable of maneuvering and shifting position quickly to avoid anti-satellite (ASAT) weapons and other active/passive measures from enemy forces that surely will be a part of future warfare.

Although direct nuclear attacks on a geostationary satellite are highly unlikely, a nuclear detonation in low earth orbit would not be that difficult to produce. Satellites in low earth orbit would suffer severe damage even from indirect. The resulting radiation from such blasts would cause extensive damage and disrupt communications for extensive periods of time to satellites passing through the debris field.

The problem today with ground-based operational and tactical control of satellites is the long communications links and time delays from ground terminals to the satellite systems. For example, if a surveillance satellite in geostationary orbit detected the launch and imminent attack of an ASAT, theoretically it would take, at best, at least one quarter of a second for the information to reach a ground controller and then for the controller to send a command to the satellite to maneuver out of the way (0.012 seconds each way). In reality, it would take much longer. It would take the satellite seconds to interpret the data it had accumulated on the movement of the incoming ASAT, switch on its transmission system, and pass the information down to the ground controller. Since it is unlikely that the satellite would be directly over the ground station, the signal would have to pass through several intermediate links before arriving at the ground station's monitor. Not counting the time required for interpretation of the incoming data and decision making, the mere process of communicating would take several very long seconds. By the time the maneuver command arrived back up, the satellite would probably not be around to receive it.

In the Army-2010 and Beyond timeframe, the only solution to enemy ASATs that might be feasible is to place the sensor and specific battle management functions (monitored by a human) on a single platform. This would eliminate the time delays. It would also eliminate the long communications lines vulnerable to jamming, disruption by weather/natural causes, and electronic hijacking. Ground stations that are vulnerable to missile attacks are also better protected.

ARMY- 2010 AND BEYOND SATELLITES IN COUNTERSPACE OPERATIONS

Offensive Operations

Offensive counterspace operations would seek to neutralize enemy space capabilities before they can be employed against military and civilian targets. Offensive missions would include targeting enemy space capabilities on the ground (e.g., launch pads, control facilities, and terminals), satellites already in space, and satellite links. Four offensive strategies that could be used to render enemy satellite systems inoperative are the following:

- Attack the ground stations directly, destroying the ability to receive and distribute information
- Attack satellite systems physically, using missiles or other solid projectiles
- Attack satellite systems using high-energy/laser beams
- Disrupt, corrupt, or supplant the flow of data from ground to space, using electronic warfare techniques

A variety of tools will be needed by a future warfighting commander to conduct these very specialized but

Denying access to space to enemy forces requires specific weaponry that does not yet exist.

The ability of satellites to see the enemy, to strike with precision, to shoot and destroy with deadly accuracy, and to pass cricial communications, will make control of space a fundamental necessity.

critical missions. Denying access to space to enemy forces requires specific weaponry that does not yet exist. At least publicly, there seems to be no real hurry to develop that weaponry that would give the U.S. control over space. [The 1995 National Intelligence Estimate projected that it would take a developing country (such as North Korea or Iran) at least 15-20 years before it could threaten the continental United States with a long-range missile developed indigenously]. Apparently, the belief is that the realistic threat from other countries does not justify the enormous expenditure of funds that would be required to emplace the necessary space platforms.

As more countries acquire the technology to launch and maintain satellites that may threaten the U.S. use of space, plans must be developed to protect our national interests. The ability of satellites to see the enemy, to strike with precision, to shoot and destroy with deadly accuracy, and to pass critical communications, will make control of space a fundamental necessity. Identification and monitoring of enemy satellite links would enable U.S. forces to target unique links for denial, disruption, degradation, or destruction.

In the Army-2010 and Beyond, it would not be inconceivable for the U.S. to launch a series of small LEO satellites to provide continuous coverage over a specific battle area. Held in reserve and placed in a higher orbit, would be a fleet of unmanned weapons platforms that could be moved into orbital position where they would traverse the battlefield. Manned space command platforms, controlling the weapons satellites would respond to calls for fire from the ground and order launches. The space-based, precision-guided munitions would then guide themselves to the precise point requested by ground commanders.

Manned space control headquarters located in orbit will become the center of activity in future warfare. They would run the sensor and weapons systems on the fleet of satellites they control as well as operate defense systems to protect space assets from attack. Additionally, since repairing satellites in orbit is cheaper than launching new ones, these space centers would spawn smaller repair vessels that could handle everything from routine maintenance to battle damage repairs.

At the more conventional end of the offensive counterspace spectrum is the physical destruction of specific enemy space capabilities. Force-on-force strikes might become necessary to destroy enemy targets or supply lines. Directed energy weapons (ground or space-based lasers) are options for global or theater control. Kinetic energy weapons (the old-fashioned way to take out targets) from the surface, air, or ground would provide the best kill capabilities in a specific area, if time and range from the target were limitations.

Defensive Operations

Defensive satellite counterspace operations consist of active and passive measures designed to reduce the effectiveness of enemy space systems targeted against friendly interests. Active defense measures detect, identify, intercept, and disrupt or destroy enemy space systems. Passive defense involves protecting friendly space assets by satellite design and maneuver, warning commanders of enemy space threats, and minimizing these threats through camouflage, deception, and decoys.

Space-based sensors will be the foundation of the Army-2010 and

Beyond threat defensive strategy. Speed-of-light weapons will handle accurate interception and destruction of incoming missiles. To understand the incredible speed of these weapons is analogous to the destruction of a speeding bullet, which, to the speed-of-light weapon, is virtually standing still.

In the Army-2010 and Beyond timeframe, a power source for directed-energy weapons would need to be so technologically advanced that it could generate a large amount of energy quickly and then repeat the surge as the weapon re-targets a few seconds later. Any one of the following weapons, based in space, controlled by computers, and hooked to satellite sensors could destroy a large number of ICBMs assuming a suitable advanced power source were available:

• *Long-wavelength lasers:* These are lasers that use energy in the infrared band. Energy is chemically generated, and mirrors positioned at strategic points can redirect the beam. The infrared lasers heat the surface of an enemy Inter-Continental Ballistic Missile (ICBM), causing internal damage.

• *Short-wavelength lasers*: These generate free-electron beams, generated by various power sources, including possibly nuclear reactors. Focused by an array of magnets, powerfully fused electrical energy is projected. Wavelengths can be tuned to penetrate the atmosphere or for other purposes. On the whole, these lasers are more powerful than long-wavelength lasers.

• *Microwave weapons*: These use high-powered microwave radiation to disrupt the guidance system of missiles. They would be powered either chemically or by space-based nuclear reactors.

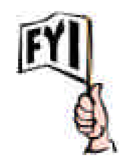
• *Nuclear-particle beams*: A beam of neutrons is charged and directed at Inter-continental Ballistic Missiles. They would penetrate the target and destroy critical systems internally. They would require large chemical chambers or a nuclear reactor.

SUMMARY

This chapter has provided a glimpse into the use of SATCOM technology by the Army warfighter in the future, from Force XXI to Army-2010and Beyond. This vision foresees advanced telecommunications services using UAVs, multiband satellite constellations, and superior antenna and ground terminal technologies that would extend into a worldwide terrestrial fiber-optic network in a clean, seamless manner (figure 12-4).

Because SATCOM resources are joint, the development of the Army vision must be closely tied to the visions and efforts of DoD, sister services, and major Army commands. DoD space policies, architectural options, funding and requirements all must be considered and fused together with Army concepts and requirements for a vision. This vision must be reviewed and adjusted as needed to keep pace with technology and funding developments. It is not static. Army concepts today have a direct influence on future architectures and capabilities. They guide technology development.

Future SATCOM systems supporting the warfighter must come on line without any degradation or gap in the quantity or quality of required communications. Backward compatibility should ensure a smooth transition between new and legacy systems. Commercial SATCOM systems will be heavily used when possible to take advantage of the rapid developments in technology.



The vision of the future of Army SATCOM will continue to evolve. This is due to changes in doctrine, technology, resource allocation, and most importantly, the recognition by Army leadership of the value and importance of the SATCOM mission-to-mission success.

Future ground terminals will be smaller and lighter, with embedded security features. They will be handheld or smaller and much easier for the future warfighter to use and store. They should be able to interface with all battlefield functional areas and be multi-purpose, multi-band capable. A terminal of this type would significantly increase the mobility of the warfighter and add to the chances of his survival.

Finally, the important point to be made is this - for all the futuristic, spectacular technology envisioned, the soldier on the ground must be kept at the forefront in any planning and development of SATCOM systems. This warfighter wants to travel light, and new technology must not weigh more than its worth for a foot soldier. It must be proven to work as needed under the most brutal of battlefield conditions. The push to develop and field high-technology SATCOM systems to the warfighters will not reduce battle casualties if the soldier is not trained properly. The soldier must be able to use it effectively. Superior training coupled with reliable equipment wins wars and this will be as true in 2025 as it is today.

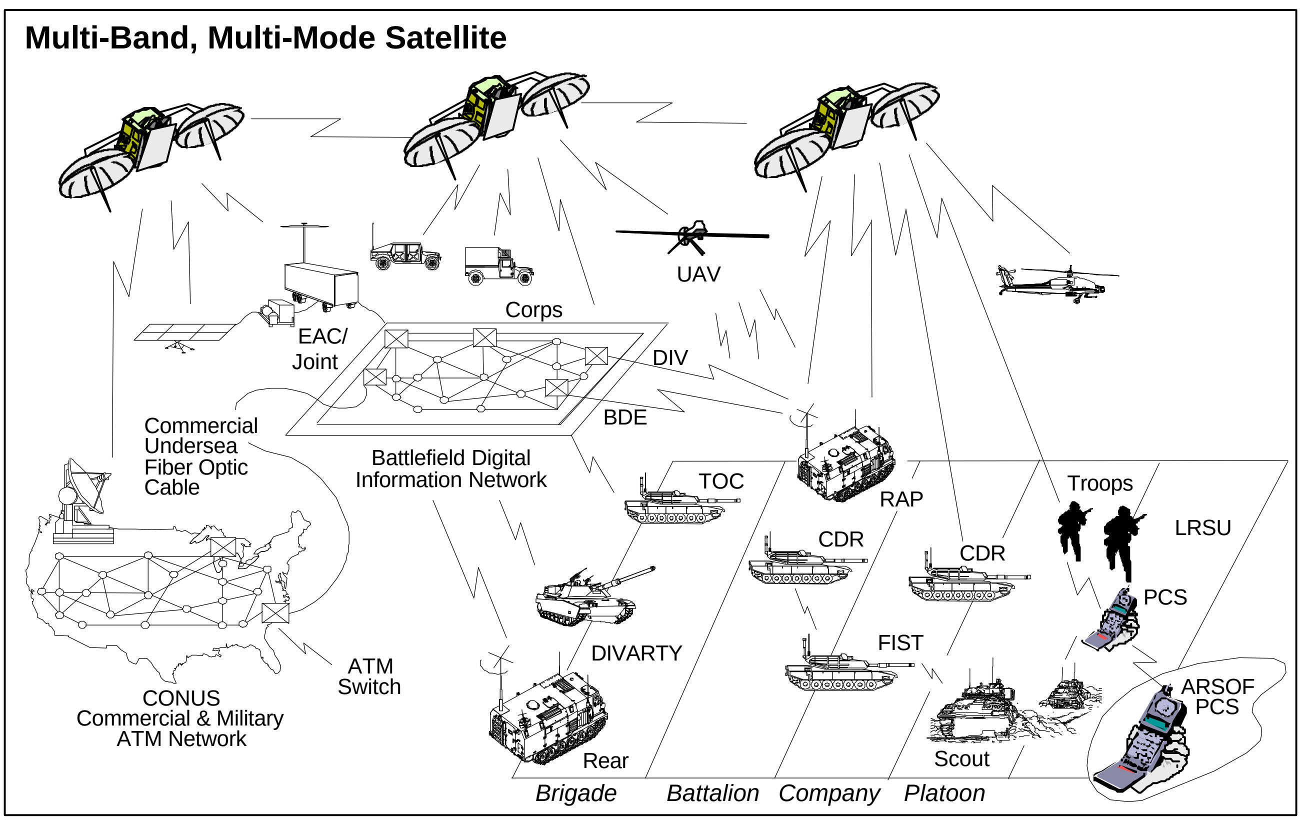


Figure 12-4. Superior Technology and Commercial Synergy are Keys to Army Future SATCOM

AEHF
Advanced Extremely High Frequency

ANC
Advanced Narrowband Concept

ASAT
Anti-Satellite

AWS
Advanced Wideband Satellite

CRD
Capstone Requirements Document

DOD
Department of Defense

DSCS
Defense Satellite Communications System

EHF
Extremely High Frequency

GBS
Global Broadcast Service

GPS
Global Positioning System

LEO
Low Earth Orbit

LPI/LPD
Low Probability of Interception/Low Probability of Detection

MILSATCOM
Military Satellite Communications

MIST
Multimode Integrated Satellite Terminal

MUOS
Mobile User Objective System

ORD
Operational Requirements Document

SATCOM
Satellite Communications

SHF
Super High Frequency

SLEP
Service Life Extension Program

SMDC
Space and Missile Defense Command

TRADOC
Training and Doctrine Command

UAV
Unmanned Aerial Vehicle

UFO
UHF Follow On

UHF
Ultra High Frequency

USSPACECOM
U.S. Space Command

WIN
Warfighter Information Network